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(54) Method and sprayer for series-coating workpieces

(57) The air ring of a rotation sprayer for series-coating workpieces such as vehicle bodies guides separately controllable air streams (50, 51) onto the spray cone that exit at different radial differences from the sprayer axis and serve to adjust the spray jet width within different ranges so that the spray jet of the same sprayer can be optimally adapted to the area of the workpiece to be coated.

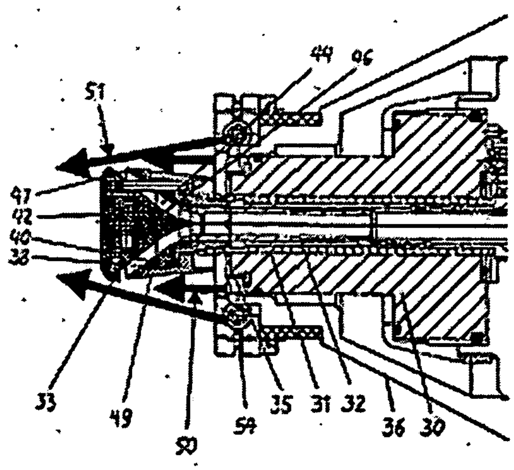

Fig. 3

Description

[0001] The invention concerns a method to coat a workpiece, and a sprayer for series-coating workpieces with outlets for a gas flow delimiting the spray cone according to the preamble of the independent patent claims. In particular, the invention concerns the control of guided air in electrostatic rotation sprayers that are conventionally used to series-coat workpieces such as car bodies. The invention can also concern other types of sprayers as well. The invention is suitable for any coating material including wet and powdered paint.

[0002] In conventional rotation sprayers (DE 4306800) that atomize the coating material with a bell and that rotates at more than 40,000 RPM, air is directed from the sprayer to the conical outer surface of the bell. This provides thrust in the direction of the workpiece for the paint particles sprayed off radially from the paint bell edge in addition to the electrostatic force. Furthermore, it also serves to shape the spray jet and partially supports atomization. The guided air departs from a ring of holes in the face of an air ring mounted to the front end of the sprayer housing. The number, diameter, shape and direction of the holes can vary to optimize the air speed, quantity of air and spray jet width. The desired amount of guided air which also produces the spray jet width is specified as a parameter in the coating process and is regulated in a close loop.

[0003] Instead of holes, arrangements of outlets in the shape of annular gaps can be provided for the guided air. In a prior-art rotation atomizer in EP 0092043, there is an outer annular gap for the actual guided air in addition to a radial inner annular gap; the outer annular gap is supplied by a compressed air source like the inner annular gap. The width of one or both annular gaps can be adjusted. The outer air layer supplied from the additional annular gap is assigned the task of compensating for the edge turbulence arising from the cloud of paint in conjunction with the inner air layer and returning stray paint particles into the cloud.

[0004] There are also prior-art rotation sprayers that have radial outer auxiliary outlets for air in addition to the radial inner air openings that prevent the paint particles from returning into the sprayer.

[0005] The general problem with sprayers is that spray cones with different widths are required for different areas of the workpiece. Prior-art high-speed rotation sprayer systems e.g. for painting vehicle bodies are preferably designed so that spray bells with a larger diameter are used for painting flat areas, and spray jet widths (defined as "SB 50%," i.e. the width given 50% of the maximum layer thickness of the individual profile) are set at approximately 300 to 550 mm. For detailing and interior painting as well as for mounted and small parts such as mirrors, strips and bumpers, smaller spray bells and jet settings of 180-300 mm are more useful. With smaller or narrower spray patterns, the paint application efficiency defined as the ratio between the sprayed material and deposited material is higher than with wide spray patterns, which saves a substantial amount of paint and expense.

[0006] Prior-art sprayers are found in EP 1114677 with exchangeable bells that have different diameters, spray directions and amounts of guided air. They are selected depending on the shape of the objects to be coated and the color, etc., for example with a large diameter for external surfaces and a small diameter for interior surfaces of vehicle bodies.

[0007] in practice, the interior surfaces of vehicle bodies such as door sills, door folds, trunks, engine compartments and hood interiors have previously not been coated with rotation sprayers, but usually with spray guns that atomize the paint by compressed air as opposed to rotation. These spray guns generate a long, relatively sharply concentrated spray pattern that is better for coating the narrower surfaces in the interior than the previously conventional large-area, round spray patterns produced by rotation sprayers. Especially when painting the interior with powder, coating problems can arise from the spray guns due to powder sintering (spitting) that is time-consuming to fix. In addition to

the quality of the coat, the application efficiency of spray guns is worse than rotation sprayers.

[0008] If both wide and narrow spray settings are required when painting an entire workpiece to obtain high application efficiency and an even overall coat and to not interrupt the coating process by exchanging spray heads, compromises in the efficiency, amount of paint consumed, and shade must be reached when choosing a paint bell size with an appropriate air supply and jet width because the spray jet cannot be adjusted to be sufficiently narrow. By reducing the speed, the spray jet can be narrowed, but the atomization is less fine, and the coat quality is worse. Since it has been previously impossible to use the guided air of a given sprayer to adjust the spray jet for optimal use within one or the other of the above-cited width ranges, substantial disadvantages have arisen in practice such as problems with coating or the inability to coat the interior or details, increased overspray (the amount of paint sprayed past the edge of the object) reduced application efficiency, increased paint use, and poor coat quality.

[0009] The invention is based on the task of avoiding the prior disadvantages and presenting a method and sprayer that allow the spray jet width to be set without mechanically controlling the outlet arrangement to achieve a substantially larger width range than before and still optimize coating with favorable application efficiency and good coat quality.

[0010] This task is solved by the features of the patent claims.

[0011] In an initial exemplary embodiment of the invention, this is enabled without exchanging the spray head and without mechanically changing the outlet arrangement. In a second exemplary embodiment, it can contrastingly be useful to change the sprayer bell and/or the outlet opening arrangement for the flows of guided air depending on the areas to be coated.

[0012] The minimum of 2 guided air flows regulated in a closed loop (or other gas flows serving the same purpose) are not normally generated simultaneously in the first exemplary embodiment but are rather generated selectively depending on the workpiece or workpiece areas to be coated. However, both independently regulated air flows can also be used together.

[0013] The invention allows complex workpiece geometries to be painted, especially entire car bodies including the interior, exterior and details using the same rotation sprayer. The attainable paint application efficiency is maximized by spray jet widths that can be specifically adjusted within the entire necessary range. The two jets of guided air that can be controlled independently allow the spray jet widths to be optimally adapted to the coated object.

[0014] The optimally adapted spray jet produces less total overspray than before which results in greater application efficiency and less paint consumption. This optimization also improves the coat quality.

[0015] The invention will be further explained with reference to the exemplary embodiment in the drawing. Shown are:

Fig. 1	A rotation sprayer with an air ring according to the invention;
Fig. 2a	A section of an air ring of the sprayer from Fig. 1;
Fig. 2b	A top view of the air ring from Fig. 2a seen from the left;
Fig. 3	A rotation sprayer for powdered paint; and
Fig. 4	A schematic front view of the sprayer from Fig. 3.

[0016] Apart from the control of the guided air of the spray jet described in this document, the electrostatic high rotation sprayer shown in Fig. 1 can correspond to the state-of-the-art, for example according to the cited DE 4306800. In a manner known per se, an air ring 4 is seated on the end face of the sprayer housing 2 facing the spray bell 1 coaxial with the sprayer axis 3. The holes 12, 13 described below for the exiting guided air for setting the spray jet width ends in the radial face 5 of the air ring 4 that faces the paint bell 1 and hence the spray cone formed by the sprayed coating material. The peripheral surface 7 of the ring body 4 expanding conically to the rear abuts without a step with the bordering peripheral surface 8 of the housing 2. The continuous external shape of the entire sprayer parameter prevents air from swirling around the sprayer and the spray procedure from undesirably affecting the paint bell 1, and prevents the sprayer housing from becoming soiled.

[0017] As in the portrayed exemplary embodiment, the face 5 of the air ring 4 can be located axially to the rear of the paint bell 1, and it can extend radially inward nearly to the hollow shaft of the air turbine driving in the paint bell. The air ring can also be completely inserted into the open front end of the sprayer housing. In other embodiments, the outlet arrangement of the air ring can extend further forward in an axial direction beyond the paint bell.

[0018] Fig. 2a and Fig. 2b show the air ring 4 per se. Two rings of air holes 12, 13 spaced at even angular distances end in the face 5 on two graduated circles 10, 11 with different diameters and concentric to the sprayer axis 3 (Fig. 1) and hence to the spray cone axis.

[0019] In the portrayed example, the holes 12 and 13 can end axially parallel in the face, however other arrangements are possible. The radial, inner holes 13 are fed by an annular channel 14 within the air ring 4 that is connected to the compressed air line (not shown) of the sprayer, whereas the outer holes 12 of the air ring 4 proceed from the face 5 first axially and then as shown with a rear part 16 approximately parallel to the

peripheral surface 7 and radially to the outside up to an annular channel 17 that is formed between the rear of the air ring when it is installed and the neighboring parts of the sprayer, and that is fed by another compressed air line of the sprayer.

[0020] Instead of the two rings of holes 12, 13, annular-gap-like outlet arrangements can be in an air ring or possibly in separate components of the sprayer.

[0021] The cited two compressed or lines can for example be connected to a compressed air connector of the sprayer for external lines that can each lead to their own air control system. For example, when two separate air controllers are too involved, the compressed air lines can also be connected via the switchover valve (controlled depending on the workpiece area to be coated) to an air control system shared by the holes 12 and 13. The switchover valve does not have to be outside of the sprayer; it can rather be installed in the sprayer, for example in the valve unit 18, so that only a single external air connection is necessary. The guided air can also be controlled within the sprayer.

[0022] When coating workpieces such as vehicle bodies, the first controlled air stream from the radially interior holes 13 is preferred for creating wide spray jets (for example, for an SB 50% of 250 to 300 mm) for exterior painting The second air stream from the holes 12 on the larger graduated circle 10 controlled separately from the first air stream is set to produce narrower spray jets (for example, for an SB 50% of 50 to approximately 300 mm) for detailing and interior painting. It can be useful to overlap the two areas (as in the portrayed example). Hence one and the same sprayer can be adjusted to cover the entire spray jet width required for the exterior, interior, and detailed painting (50 to 550 mm in the considered example) without interrupting the painting process and without substantial disadvantages. The two airstreams can be used and controlled separately, i.e. while the sprayer is using one air stream, the other air stream can be turned off. The first air stream exiting behind the paint bell 1 from the inner holes 13 contacts relatively far towards the back of the conical peripheral surface of the paint bell 1 that narrows toward the rear. An air cushion is generated around the paint bell, which advantageously causes an even distribution of the air during atomization. The second air stream from the outer

holes 12 can contrastingly be aligned so that that it contacts the paint material to be atomized (or that is already partially atomized by the rotation) at a slight radial distance (for example, 1 mm) beyond the edge of the spray bell. This causes the spray jet to be narrower than the air stream from the inner holes. This maximizes application efficiency and allows difficult-to-reach or small workpiece areas to be coated well.

[0023] In another exemplary embodiment of the invention, a lengthwise section of the front part of an electrostatic rotation sprayer is e.g. mounted at the wrist of a robot as shown in Fig. 3 that is for powdered paint or another powdered coating material. Like the electrostatic wet paint sprayer in Fig. 1, the sprayer contains for example a drive turbine 30 operated by compressed air for the rotating sprayer bell 33 affixed in the front end of the hollow shaft 31. Through the hollow shaft 31 extends a coaxial cylindrical tube 32 serving as a powder channel for the sprayer into the hub 35 of the bell 33 where it ends axially outside of the sprayer housing 36 as shown. The powder tube 32 is connected in the sprayer to a powder hose (not shown) coming from an external air and powder supply. As is known, (EP 1238710; US 5353995) the sprayer bell 33 consists essentially of an outer part 38 affixed to the hub part 35, and the outer part has an inner, conical surface 40 with the portrayed shape, and an inner part 42 seated in the area in front of surface 40 that has an inner surface 46 opposite surface 40 with which it forms a gap channel 44, and which is rigidly affixed to an outer part of 38. The gap channel 44 is therefore delimited by the two conical surfaces 40 and 46. The radial, outer peripheral surface 49 of the outer and axially rear bell part 38, i.e., facing the main part of the sprayer expands only a bit conically toward the front as shown (in contrast to the cited, prior-art powder bells) so that it forms a sharp angle of preferably less than 20° with the rotational axis; in the portrayed example, it is approximately 5°. Along its path through the tube 32 and the gap channel 44, the coating powder can be charged to a high-voltage in the normal manner.

[0024] As in the exemplary embodiment in Fig. 1, a controllable air flow 50 (or another gas stream) that can be approximately axially parallel and exits radially outside of the peripheral surface 49 of the bell 33 surrounds or contacts the spray cone in a ring. Radially outside of the flow 50, there is another exiting air or gas flow 51 whose exit direction can also be axial. In the figure, it is angled sharply inward in relation to the axial direction so that it intersects the direction of the inner flow 50. The directions indicated by the portrayed arrows can run so that they do not intersect the outer surface of the bell 33 but rather pass close to the bell. The radial outer gas stream 51 can usefully be directed toward the powder exit site of the sprayer bell 33.

[0025] The radial outer stream 51 is not annular in this case like stream 50, but rather consists of separate, e.g. flat, top and bottom parts that compress into an oval cross-section (ovalize) the inner stream 50 and the spray cone that it forms when it contacts the inner stream. The outlets provided for this purpose can be seen in the schematic representation in Fig. 4. Whereas the annular guided air stream 50 departs from a circle of numerous openings 52 concentrically surrounding the rotational axis, two straight slots 53, 53' can be provided for the two flat parts of the stream 51 that run parallel tangentially to the ring formed by the openings on opposite sides of the rotational axis. The slots 53, 53' are symmetrical to the rotational axis such that the line perpendicular to lengthwise direction of their opening and connecting their midpoints intersects the rotational axis. The slots 53, 53' are fed by compressed air lines 54 at their inside facing the sprayer. Instead of two slots, parallel rows of a sufficient number of openings can be useful.

[0026] The guided air openings 52 and/or the ovalizing slots 53, 53' can be in an annular body 55 that can be removed and quickly and easily exchanged with a different air ring with another outlet arrangement in the sprayer. Along with the air ring, the sprayer bell 33 can be exchanged with another bell to adapt to the workpiece area being coated. The rest of the rotation sprayer can remain unchanged. The bells and air rings can for example be exchanged automatically by controlling the robot.

[0027] A substantial advantage of the described rotation sprayer is that the same basic sprayer can e.g. be used for programmable body painting for outer surfaces and automatically painting the interior. To paint the interior, a round jet with a smaller diameter than is used for exterior painting is usefully created that is ovalized by the flattening air flow from the slots 53, 53' at the powder exits of the sprayer bell 33.

[0028] Using a rotation sprayer for all outer and inner areas of the workpiece simplifies the automated painting procedure, improves the paint quality in comparison to previously used spray guns, and improves the coating efficiency. In addition, is easier than before to have a different robot do the job if one fails.

[0029] In other cases, however, the rotation sprayer can coat every, or at least different, workpiece surfaces with the same bell and the same outlet arrangement in the exemplary embodiment in Fig. 3 and 4. Only the gas streams 50, 51 are changed with the control loop to adapt to the respective workpiece areas.

Patent Claims

1. Method to coat a workpiece with a sprayer,
   where the spray cone of the sprayed coating material is limited by a controllable gas stream surrounding it in a ring to control the shape of the spray jet from the sprayer, and the gas stream exits from the sprayer concentric to the spray cone axis (3),
   and different areas of the workpiece are coated using different spray jet shapes,
   especially to series-coat vehicle bodies with a paint robot,
   characterized in that at least two independently controllable gas streams are generated that exit at different radial distances from the spray cone axis (3) and are used depending on the workpiece area to be coated.

2. Method according to claim 1, characterized in that one spray jet shape is used to coated outer areas of a vehicle body or the workpiece, and the same sprayer or basic parts of the same sprayer are used to coat inner areas of the body or workpiece using the other spray jet shape.

3. Method according to claim 1 or 2, characterized in that a high rotation sprayer is used.

4. Method according to claim 3, characterized in that a rotation sprayer is used whose radial outer gas stream (51) that is directed toward the annular gas stream (50) causes the spray cone to assume an oval or flattening shape when coating the inner areas.

5. Method according to one of the prior claims, characterized in that each gas stream is regulated within its own close to control loop.

6. Method according to one of the prior claims, characterized in that a regulated gas stream is supplied through a switchover valve (that is controlled depending on the workpiece area to be coated) to the radial outside or radial inside outlets (12, 13).

7. Method according to one of the prior claims, characterized in that only one gas stream is used to paint with a wide spray cone, and only the other gas stream is used to paint with a narrow spray cone.

8. Method according to claim 7, characterized in that the two ranges within which the spray cone can be adjusted overlap each other.

9. Method according to one of the prior claims, characterized in that the workpiece is coated with powdered paint.

10. Sprayer for series-coating workpieces with at least one first annular arrangement of outlets (13, 52) concentrically surrounding the spray cone axis (3) and facing the spray cone for a gas flow that narrows the spray cone, with at least one other arrangement of outlets (12, 53) facing the spray cone that have a different, especially larger radial distance from the spray cone axis than the first arrangement,
and with a gas line arrangement leading to the outlets (12, 13, 52, 53) that can be connected to at least one control loop for a gas stream, characterized in that the radial inner and radial outer gas streams are separately controllable.

11. Sprayer according to claim 10, characterized in that the radial inner outlet arrangement (13) and the radial outer outlet arrangement (12) are connected or connectable to their own closed control loop.

12. Sprayer according to claim 10, characterized in that the line arrangement leading to the outlet arrangements (12, 13) is connected or connectable via a switchover valve to a common control loop.

13. Sprayer according to claim 12, characterized in that the switchover valve is in the sprayer.

14. Sprayer according to one of claims 10 to 13, characterized in that each of the outlet arrangements (12, 13) is connected to a gas connection of the sprayer for an external gas supply line.

15. Sprayer according to one of claims 10 to 14, characterized in that the two outlet arrangements (12, 13) are in the face (5) of an annular body (4) facing the spray cone on the front-end facing the spray cone of the housing (2) holding the spray head (1) of the sprayer.

16. Sprayer according to claim 15, characterized in that the peripheral surface (7) of the annular body (4) abuts the neighboring peripheral surface (8) of the housing (2)

without a step.

17. Sprayer according to one of claims 10 to 16 or in the preamble of claim 10, characterized in that two radial outer outlet arrangements (53, 53') are provided that oppose each other at least approximately parallel on opposite sides of the spray cone axis and extend at least approximately tangentially to the annular outlet arrangement (52).

18. Sprayer according to claim 17, characterized in that the radial outer outlet arrangements consist of elongated slots (53, 53').

19. Sprayer according to one of claims 10 to 18, characterized in that the outlets (52, 53) are in a removable and exchangeable body (55) mounted on the sprayer, and that at least two exchangeable bodies (55) are provided for the sprayer with different outlet arrangements.

20. Sprayer according to one of claims 10 to 19, characterized in that the exit direction of the radial outside gas stream (2) runs close to the edge (47) of the sprayer bell (33) without intersecting the outer surface of the sprayer bell (33).

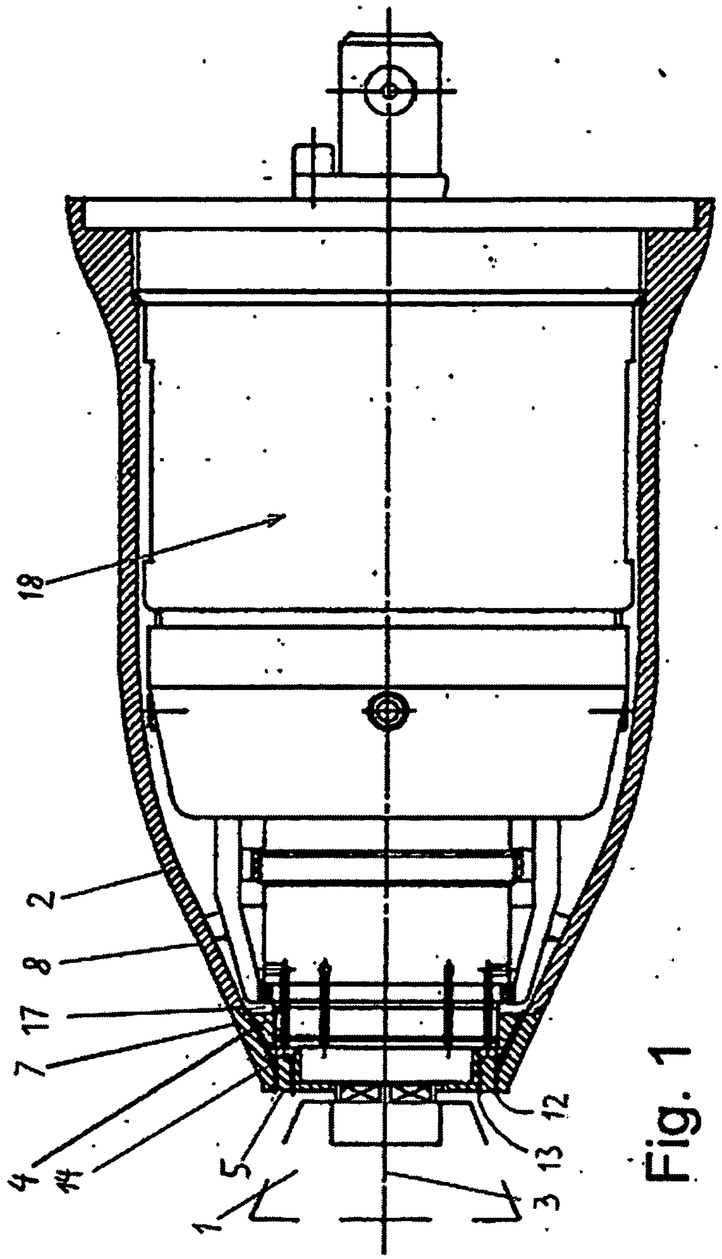

Fig. 1

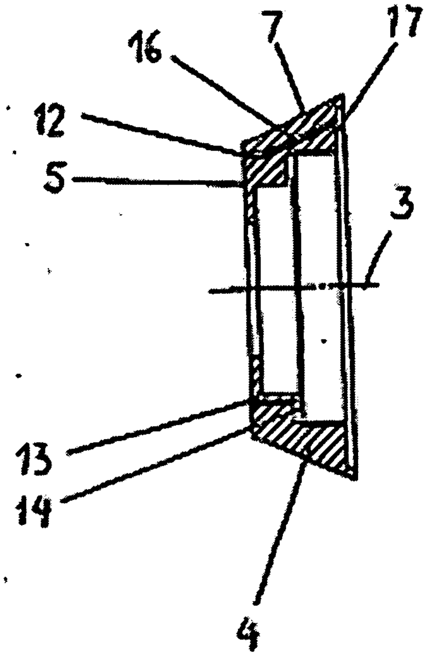

Fig. 2 a

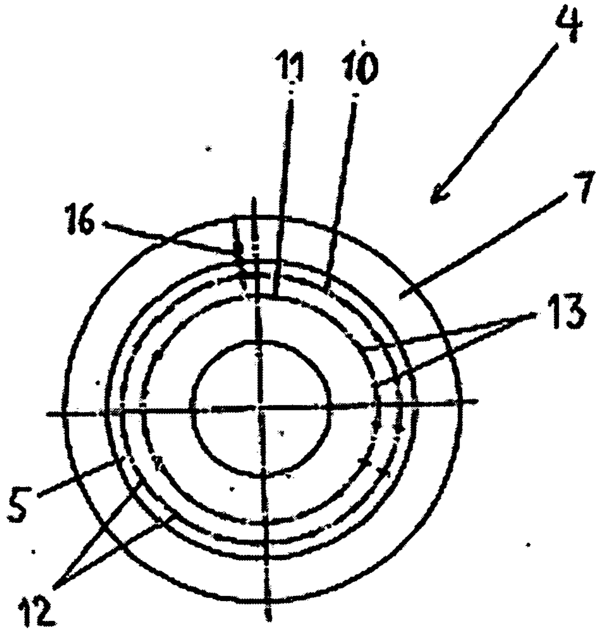

Fig. 2 b

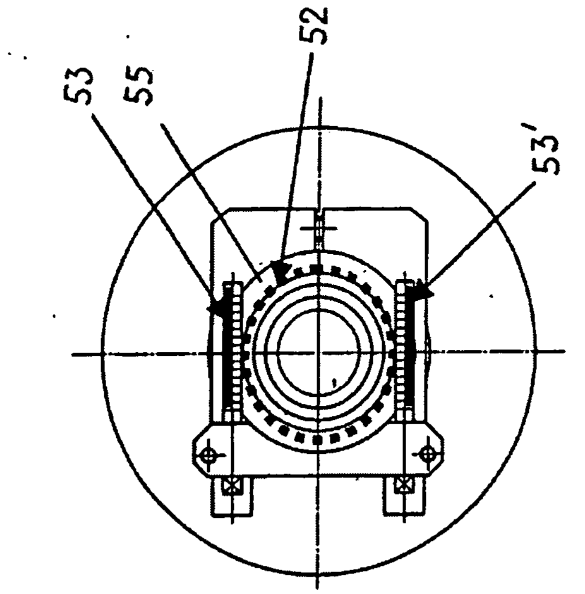

Fig. 4

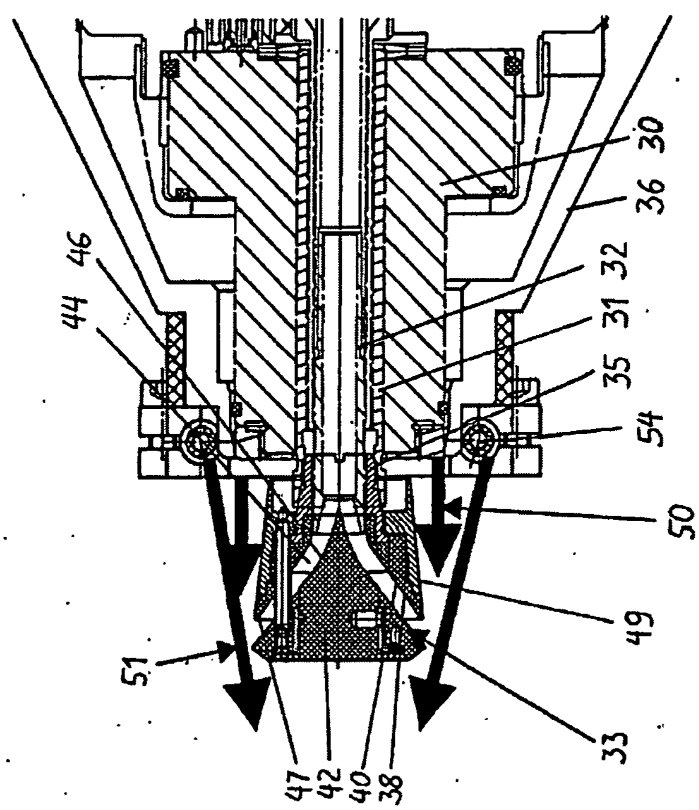

Fig. 3